CHAPTER 1

INTRODUCTION

1. INTRODUCTION

The basic concept of home had started from back to the pre historic times during the Stone Age. The basic homo sapiens and their descendants lived in caves in-order to escape from cold and wild animals. That was the first basic home. They used the skin of animal's in-order to keep the caves warm. This was the first basic coating given to wall.

Cave paintings drawn with red and yellow ochre, hematite, manganese oxide, and charcoal may have been made by early *Homo sapiens* as long as 40,000 years ago.

Ancient colored walls at Dendera, Egypt, which were exposed for many ages to the open air, still possess a perfect brilliancy of color, as vivid as when they were painted about 2,000 years ago. The Egyptians mixed their colors with some gummy substance, and applied them separated from each other without any blending or mixture. They appeared to have used six colors: white, black, blue, red, yellow, and green. They first covered the field entirely with white, upon which they traced the design in black, leaving out the lights of the ground color.

The concept of painting the homes with limestone and cow dung were introduced during the times of Pharaohs. The ancient Egyptians used a mixture of limestone and water to paint their homes and the limestone water mixture became the first made paint. They dipped fibers in the mixture and applied the coat on the walls.

In India the homes were coated with a thin layer of cow dung and water to keep their homes cool during the hot summer seasons. This was the first painting technique.

Technology keeps on growing as it is said. With the concept of polymers, synthetic paints were developed. Then came the development of binders which were used to bind the pigment to the wall. The first paint was water colored paint and it was 68% transparent. The invention of pigments into the paints gave a better appearance to the coatings. The pigment concentration gave different paint shades.

With the advance of the paints the concepts of brushes to paint were developed. This was developed by the Egyptians. Later the fibers developed artificially were used to make the brushes. Then came the roller brushes and the spray guns.

In consideration to the problems related to manual painting, such as the time consumption for painting large plane wall, the cost involved, non-uniformity of paint etc, we came up with a solution- “Automatic Wall Painting Machine”

The machine uses the basic principles of convention spray painting to paint mainly plane interior walls. It moves automatically along the wall side and with the help of simultaneous up and down motion of the painting unit, the whole area of the wall is painted. Automation has been done with the help of a microcontroller.

A striking feature of the machine is that the spray gun stops the spray of paint when it detects a vacant space on the wall, such as a window or a door. This is done using a sensor unit, consisting of an IR transmitter and receiver. This saves paint to a large extent.

With the commercialization of our project, it is expected to be a breakthrough in the painting technology.

CHAPTER 2
LITERATURE SURVEY

2. LITERATURE SURVEY

2.1 Ancient Cave Paintings

Cave paintings are the earliest expression of permanent, non-portable art, and have been found throughout the world, with the earliest attempts at the beginning of the the Upper Paleolithic period, about 40,000 years ago.

Nearly 350 caves have now been discovered in France and Spain that contain art from prehistoric times. The age of the paintings in many sites has been a contentious issue, since methods like radiocarbon dating can be easily misled by contaminated samples of older or newer material and caves and rocky overhangs (parietal art) are typically littered with debris from many time periods. Recent advances make it possible to date the paintings by sampling the pigment itself. The choice of subject matter can also indicate date, as for instance in the reindeer at the Spanish cave of Cueva de lasMonedas which place the art in the last Ice Age.

The oldest known cave art is that of Chauvet in France, the paintings of which may be 32,000 years old according to radiocarbon dating, and date back to 30,000 BCE (Upper Paleolithic). Some researchers believe the drawings are too advanced for this era and question this age.

Other examples may date as late as the Early Bronze Age, but the well-known prolific and sophisticated style from Lascaux and Altamira died out about 10,000 years ago, coinciding with the advent of the Neolithic period. Some caves continued to be painted in for a long time.

At Drakensberg Park, South Africa, now thought to be some 3,000 years old, the paintings by the San people who settled in the area some 8,000 years ago depict animals and humans, and are thought to represent religious beliefs. Human figures are much more common in African than in European rock art.

Recently, an archeological team discovered the Laas Gaa'l cave paintings outside Hargeisa in Somaliland. They show the ancient inhabitants of the area worshipping cattle and performing religious ceremonies.

Cave paintings are found in the Tassilin Ajjer mountains in southeast Algeria also in the Akakus, Mesak Settafet and Tadrart in Libya and other Sahara regions including: Ayr mountains, Niger and Tibesti.

The Cave of Swimmers is a cave in southwest Egypt, near the border with Libya, in the mountainous Gilf Kebir region of the Sahara Desert. It was discovered in October 1933 by the Hungarian explorer László Almásy. It contains rock painting images of people swimming estimated to have been created 10,000 years ago during the time of the most recent Ice Age.

Cave paintings found at the Apollo 11 cave in Namibia may be among the earliest cave art. The estimated age of the images date from approximately 23,000 – 25,000 B.CE.

Fig:1 shows the ancient paintings on the walls of the caves

Cave paintings of India date back to the prehistoric times. The finest examples of these paintings comprise of the murals of Ajanta, Ellora, Bagh, Sittanavasal, etc, which reflect an emphasis on naturalism. Ancient cave paintings of India serve as a window to our ancestors, who used to inhabit these caves

2.2 BRUSH PAINTING

Brush painting is one of the common methods of painting adopted in India. In this method the brush is dipped in a can of paint and is then applied on the walls. Paint brushes are used for applying ink or paint. Paintbrushes are primary used by artists for painted pictures. A special kind of drawing is the so called *paintbrush-drawing*, drawings only done with paintbrushes instead of pencil or pen. These brushes are usually made by clamping the bristles to a handle with a ferrule, The sizes of brushes used for painting and decorating are given in mm or inches, referring to the width of the head.

Common sizes are:

- ⅛ in, ¼ in, ⅜ in, ½ in, ⅝ in, ¾ in, ⅞ in, 1 in, 1¼ in, 1½ in, 2 in, 2½ in, 3 in, 3½ in, 4 in.
- 10 mm, 20 mm, bob 40 mm, 50 mm, 60 mm, 70 mm, 80 mm, 90 mm, 100 mm.

Bristles may be natural or synthetic. If the filaments are synthetic, they could be made of polyester, nylon or a blend of nylon and polyester. Filaments can be hollow or solid and can be tapered or un-tapered. Brushes with tapered filaments give a smoother finish.

Synthetic filaments last longer than natural bristles. Natural bristles are preferred for oil-based paints and varnishes, while synthetic brushes are better for water-based paints as the bristles do not expand when wetted.

Fig 2: Paint Brushes

A decorator judges the quality of a brush based on several factors: filament retention, paint pickup, steadiness of paint release, brush marks, drag and precision painting. A chiseled brush permits the painter to cut into tighter corners and paint more precisely.

Handles may be wood or plastic; ferrules are metal (usually nickel-plated steel).

Bristles

Bristles are of different types

- watercolor brushes which are usually made of sable, synthetic sable or nylon;
- oil painting brushes which are usually made of sable or bristle;
- Acrylic brushes which are almost entirely nylon or synthetic.

Turpentine or thinners used in oil painting can destroy some types of synthetic brushes. However, innovations in synthetic bristle technology have produced solvent resistant synthetic bristles suitable for use in all media. Natural hair, squirrel, badger or sable is used by watercolorists due to their superior ability to absorb and hold water.

Bristles may be natural — either soft hair or hog bristle — or synthetic.

- **Soft hair brushes** are made from Kolinsky sable or ox hair (sabeline); or more rarely, squirrel, pony, goat, mongoose or badger. Cheaper hair is sometimes called camel hair, although it does not come from camels.
- **Hog bristle** (often called China bristle or Chungking bristle) is stiffer and stronger than soft hair. It may be bleached or unbleached.
- **Synthetic bristles** are made of special multi-diameter extruded nylon filament, or Taklon, multi-diameter polyester and are becoming ever more popular with the development of new water based paints.

2.3 Spray Painting

Spray paint art is an art form using spray paint, traditionally on poster board, but can be done on any non-porous material, such as wood, metal, glass, ceramic or plastic. It differs from graffiti art in that graffiti is performed on buildings, trains and the like, as opposed to more traditional art surfaces.

The artist usually paints onto high gloss surfaces, or semi to non-porous surfaces including photo paper, canvas and high quality poster board. This artwork however has and can be done on almost any surface. As such it is possible to find pieces of artwork in this style on anything from glass to skateboards and hoods of cars.

Tools

- Spray paint
- Oil painters palate knife. Each artist preferring a variety of shapes and sizes.
- Magazine page - used to remove paint in a random fashion from the canvas for adding texture.
- Round bowl or bucket, lids, pans or other recycled circular objects - used for making planets by masking a texture and shadow from other paint which is applied to form the background.
- Face mask to prevent inhalation of fumes.
- Paper towels and sponges for cleaning utensils and achieving different textures.

Process:

The artist will start by creating a mental layout of how they want their picture to go. One needs to know where specific details will go (such as planets, trees, mountains, stars, haze, water, etc.)in order to layer the colors appropriately and in the right places.

The techniques is a series of well-placed layers and textures, predetermined blocking and masking using the lids, bowls and recycled objects.

They can also add ambient effects by using a painter's spatula, a window scraper and a straight edge. Sometimes the best tool is to simply use one's fingers. This process takes time and practice, but like any learned art form can become second nature to the artist.

Mechanics of Spray Painting

When spraying move your arm in a wide sweeping motion whist keeping your hand as still as possible and carry the gun in a straight line ("pass") across the work. The best way to obtain a smooth even pattern is to begin spraying about 6 inches before the work and 6 inches after the work and then release the trigger. After a few passes this will become second nature and the small amount of paint lost will be insignificant.

Before you begin to spray adjust the gun to the widest fan as possible to reduce the amount of passes needed to complete the work. The gun should be held approximately 6 to 8 inches away from the work. When spraying smaller pieces reduce the size of the fan and spray slightly closer to the work. You will quickly ascertain the correct size of fan and the distance to hold the gun for each piece of work. It is important to move the gun at the same speed as a brush stroke, however if the material is going on too light or too heavy then you must increase or decrease the speed of the pass. A pass should overlap the previous pass by approximately 50% or 100% if the previous pass is a light tack coat. A pass should also follow the same direction as the previous one to avoid criss-crossing as this can result in uneven coverage.

Fig 3: Spray Painting Apparatus

2.4 Roller Brushes:

Working with a roller is even less exacting than working with a brush. Even a novice painter can get the feel of it in just a few minutes.

As with brushes, moisten the roller first with water for latex paint or the appropriate thinner for other types of paint. Roll out the excess moisture on a piece of scrap lumber or kraft paper or even on a paper grocery bag. Don't use newspaper because the roller may pick up the ink. Fill the well of the roller pan about half full, and set the roller into the middle of the well. Lift the roller and roll it down the slope of the pan, stopping just short of the well. Do this two or three times to allow the paint to work into the roller. Then, dip the roller into the well once more, and roll it on the slope until the pile is well saturated. You'll know immediately when you've overloaded the roller. It will drip en route to the wall and have a tendency to slide and smear instead of roll across the surface.

Fig 4: Roller Brushes

The most effective method of painting with a roller is to paint 2-or 3-square-foot areas at a time. Roll the paint on in a zigzag pattern without lifting the roller from the wall, as if you're painting a large M, W, or backward N. Then, still without lifting the roller, fill in the blanks of the letters with more horizontal or vertical zigzag strokes. Finish the area with light strokes that start in the unpainted area and roll into the paint. At the end of the stroke, raise the roller slowly so it does not leave a mark. Go to the next unpainted area, and repeat the zigzag technique, ending it just below or next to the first painted patch. Finally, smooth the new application, and blend it into the previously finished area.

Professional painters also suggest starting with a roller stroke that moves away from you. On walls, that means the first stroke should be up. If you roll down on the first stroke, the paint may puddle under the roller and run down the wall. In addition, be careful not to run the roller so rapidly across the wall that centrifugal force causes it to spray.

2.5 Airless Spray Painting

For larger painting jobs, an airless sprayer is the most efficient way to apply paint. An airless sprayer uses an electrically run hydraulic pump to move paint from a bucket or container, through a tube, into a high-pressure hose, to a spray gun, and, finally, to the surface. Once you get the knack of it, an airless sprayer is easy to use, but if you rent one, make sure you get a set of written instructions.

The instructions will tell you how to flush the system with solvent (usually water or mineral spirits, depending on the paint you'll be using) and how to pump the paint through the hose to the spray gun. For cleanup, the procedure is reversed: Pump the leftover paint out and flush with solvent.

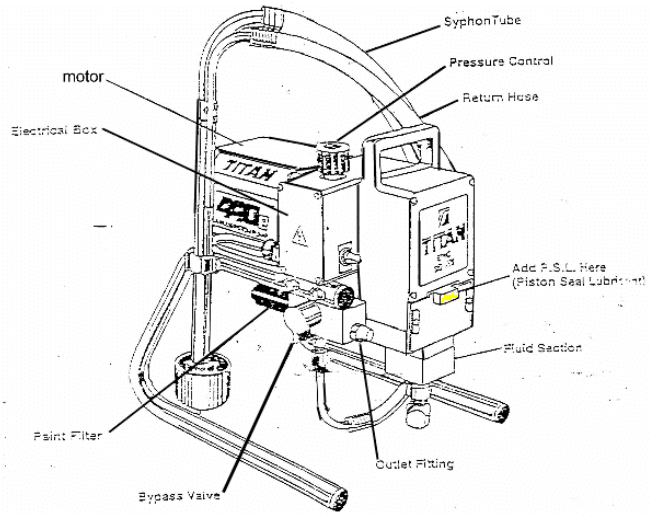
You'll only need the spray rig for a day or two, but plan to spend at least another day beforehand to thoroughly mask off everything you don't want to paint. Tape drop cloths to every floor surface. Drape windows, the fireplace, and doors. Remove all hardware or cover it with masking tape. Mask switches and outlets. Paint from a sprayer travels on the tiniest of air currents and settles a fine mist of overspray on just about every surface in a room.

Plan to keep at least one window in each room open and set up an exhaust fan to draw paint vapor out of the room. Be sure, too, to wear a painters' mask, a hat, and old clothes with long sleeves to protect your arms.

Airless sprayers are equipped with several filters to keep paint particles and foreign matter from clogging the spray tip, but it's a good idea to filter the paint yourself through a nylon stocking or paint filter before you pump the paint through the hose.

Using an airless sprayer effectively takes some getting used to, so plan to practice on some scrap plywood or an inconspicuous part of the room or the house. The object is to cover the surface with a uniform coating of paint. Hold the spray gun a constant 6 to 12 inches from the surface and maintain this distance with each pass of the gun. Keep the gun precisely parallel to the wall. Don't sweep it back and forth or you'll end up with a wide arc of paint on the wall; the paint will be concentrated in the middle of the arc and almost transparent at each end.To prevent paint buildup at the end of each strip, release the trigger on the gun a fraction of a second before the spray gun stops moving at the end of your stroke. When beginning a new strip, start moving the gun a fraction of a second before compressing the trigger. Always keep the gun moving when it's spraying.

Airless sprayers are fast and efficient because they supply pressures of up to 3,000 pounds per square inch. This force moves the paint at 100 to 200 miles an hour through the spray tip. All that power can be dangerous.



Airless Spraying Equipment

CHAPTER 3

OBJECTIVES

3.OBJECTIVES

- It should paint maximum area of a wall within minimum amount of time.
- It should operate automatically, once the inputs are given.
- It should detect gaps like windows and doors on the wall and avoid the spraying of paint over them.
- It should spray the paint during the downward motion as well as the upward motion, but cut off the spraying during the time of sideways motion.
- The painting should be as uniform as possible.
- It should be economical to manufacture.
- It should be economical to install and should require little attention during operation.

CHAPTER 4

COMPONENTS

COMPONENTS

The body of the Automatic Wall Painting Machine Consists of two major parts:

1. The Painting Unit:

It is vertical detachable frame consisting of the following components:

- The Vertical Frame
- Spray Gun
- IR Sensor Unit
- Chain and Sprocket

2. The Casing with the Control Unit

It is the major part of the Automatic Wall Painting Unit. It is a horizontal base frame on which the major components of the machine are fixed. The Major components include:

- The Base Frame
- Control Unit- The micro-controller “89C52”
- Battery
- Relay
- Solenoid Valve
- Bearings with bearing caps
- Wheels
- 2 DC Motors (Up-down and translational motions)
- 2 Gear Sets (For power transmission)
- Compressor (External)

4.1 CONTROL UNIT -89C52

In our project 89C52 Microcontroller is used as a control unit.

4.1.1 Introduction to Micro-Controller:

A microcontroller consists of a powerful CPU tightly coupled with memory (RAM, ROM or EPROM), various I/O features such as serial port(s), parallel port(s), Timer/Counter(s), Interrupt controller, Data Acquisition interfaces-Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), everything integrated onto a single silicon chip.

It does not mean that any micro controller should have above said features on-chip. Depending on the need and area of application for which it is designed, the on-chip features present in it may or may not include all the individual sections said above. Any micro computer system requires memory to store a sequence of instructions making up a program, parallel port or serial port for communicating with an external system, timer/counter for control purposes like generating time delays, baud rate for the serial port, apart from the controlling unit called the Central Processing Unit.

4.1.2 Memory associated with AT-89C52:

Program memory:

A program memory is a block of memory, which can be used to store a sequence of program codes (by using special EPROM / PROM programmers). It can only be read from and not written into, under normal operating conditions. There can be up to 64 k bytes of program memory in AT-89C52. In ROM and EPROM versions of the MCS-351 family of devices, the

lower 4K are provided on-chip whereas in ROM fewer versions, all program memory is external. In ROM and EPROM versions of this device, if the special control signals EA (External Access enable) is strapped off Vcc, and then program fetches to addresses 0000 to 0FFF are directed to the internal ROM. The program fetch will be from external memory, where EA* is grounded. After reset, the CPU begins execution from address location 0000 of the program memory.

Timers/Counters:

AT-89C52 has two 16-bit timer/counter 0, and timer/counter 1. They can be configured in any of the four operating modes, which are selected by bit-pars (m1, 0) in register TMOD (Timer/counter Mode control). Modes 0, 1 and 2 are the same for the timer/counters. Mode 3 is different.

4.1.3 Features of AT-89C52:

Nowadays an 8-bit AT-89C52/8031/8751 and 16 bit 8097 micro controllers available in the form of kits. Its special features are summarized as:-

- 4k Bytes of Flash
- 128 Bytes of RAM
- 32 I/O lines
- On chip Oscillator and clock circuitry.

4.2 BATTERIES

4.2.1 Introduction:

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

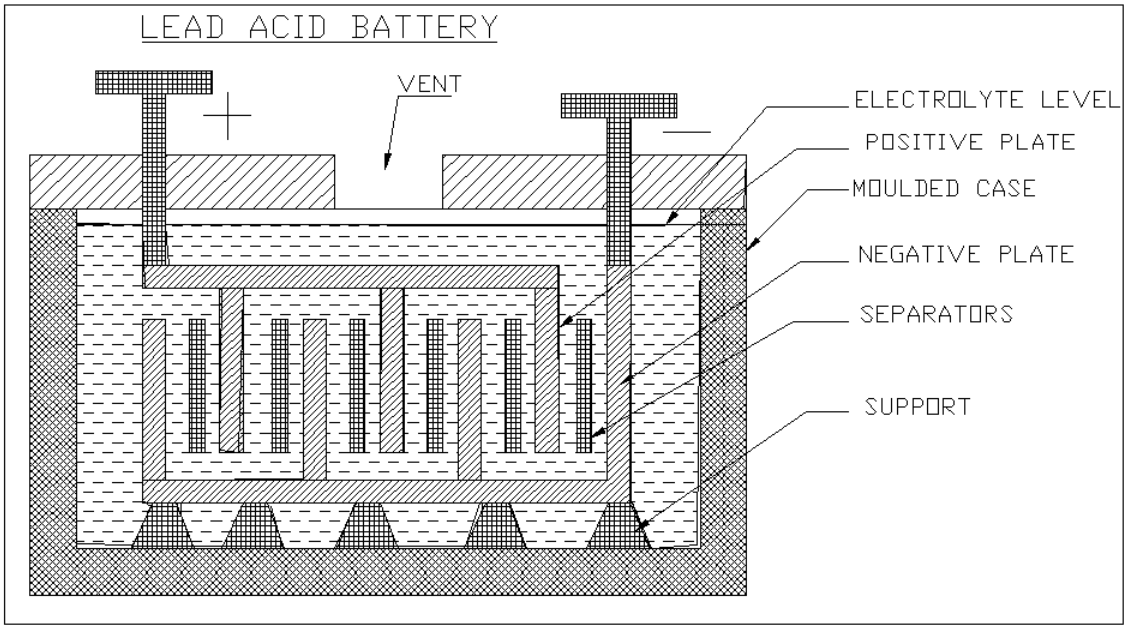
(1) Low cost
(2) Long life
(3) High reliability
(4) High overall efficiency
(5) Low discharge
(6) Minimum maintenance
    (A) Ampere hour efficiency
    (B) Watt hour efficiency

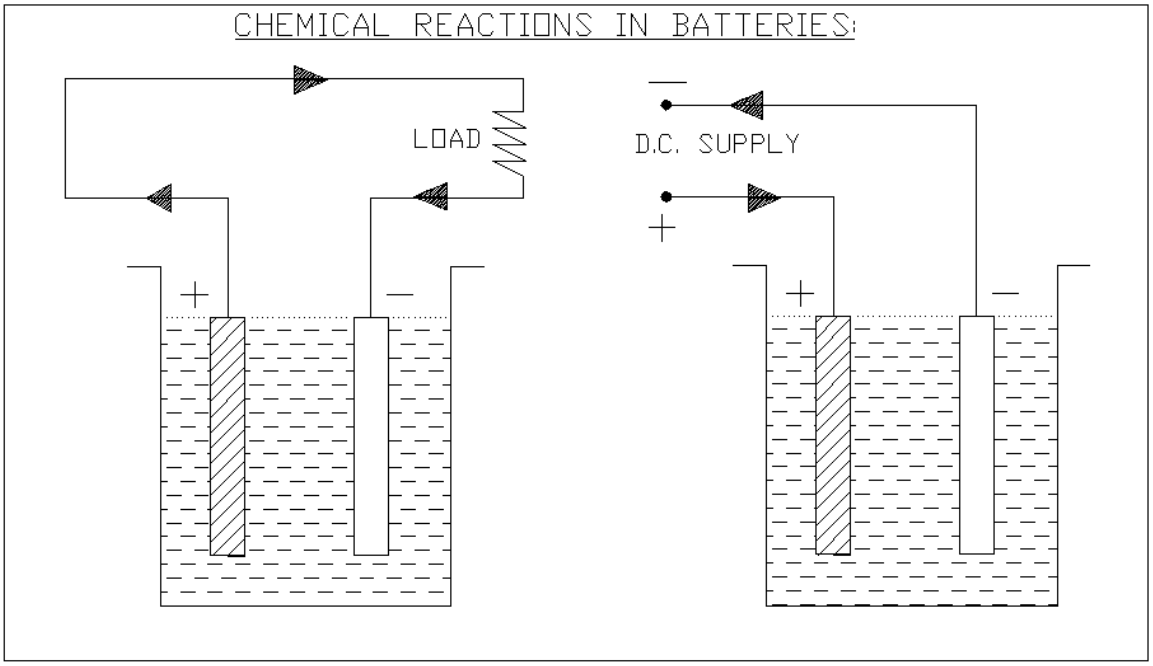
We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and so about the lead acid cells are explained below.

Lead-Acid Wet Cell:

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.

The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortends the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.





The chemical equation for the lead-acid cell is

Charge

$Pb + pbO_2 + 2H_2SO_4 \rightleftharpoons 2pbSO_4 + 2H_2O$

Discharge

4.2.2 Current Ratings:

Lead-acid batteries are generally rated in terms of how much discharge currents they can supply for a specified period of time; the output voltage must be maintained above a minimum level, which is 1.5 to 1.8V per cell. A common rating is ampere-hours (A.h.) based on a specific discharge time, which is often 8h. Typical values for automobile batteries are 100 to 300 A.h. As an example, a 200 A.h battery can supply a load current of 200/8 or 25A, used on 8h discharge. The battery can supply less current for a longer time or more current for a shorter time. Automobile batteries may be rated for “cold cranking power”, which is related to the job of starting the engine. A typical rating is 450A for 30s at a temperature of 0 degree F. Note that the ampere-hour unit specifies coulombs of charge. For instance, 200 A.h. corresponds to

200A*3600s (1h=3600s). the equals 720,000 A.S, or coulombs. One ampere-second is equal to one coulomb. Then the charge equals 720,000 or 7.2*10^5ºC. To put this much charge back into the battery would require 20 hours with a charging current of 10A. The ratings for lead-acid batteries are given for a temperature range of 77 to 80ºF. Higher temperature increase the chemical reaction, but operation above 110ºF shortens the battery life.

Low temperatures reduce the current capacity and voltage output. The ampere-hour capacity is reduced approximately 0.75% for each decreases of 1º F below normal temperature rating. At 0ºF the available output is only 60 % of the ampere-hour battery rating. In cold weather, therefore, it is very important to have an automobile battery unto full charge. In addition, the electrolyte freezes more easily when diluted by water in the discharged condition.

4.3 RELAY

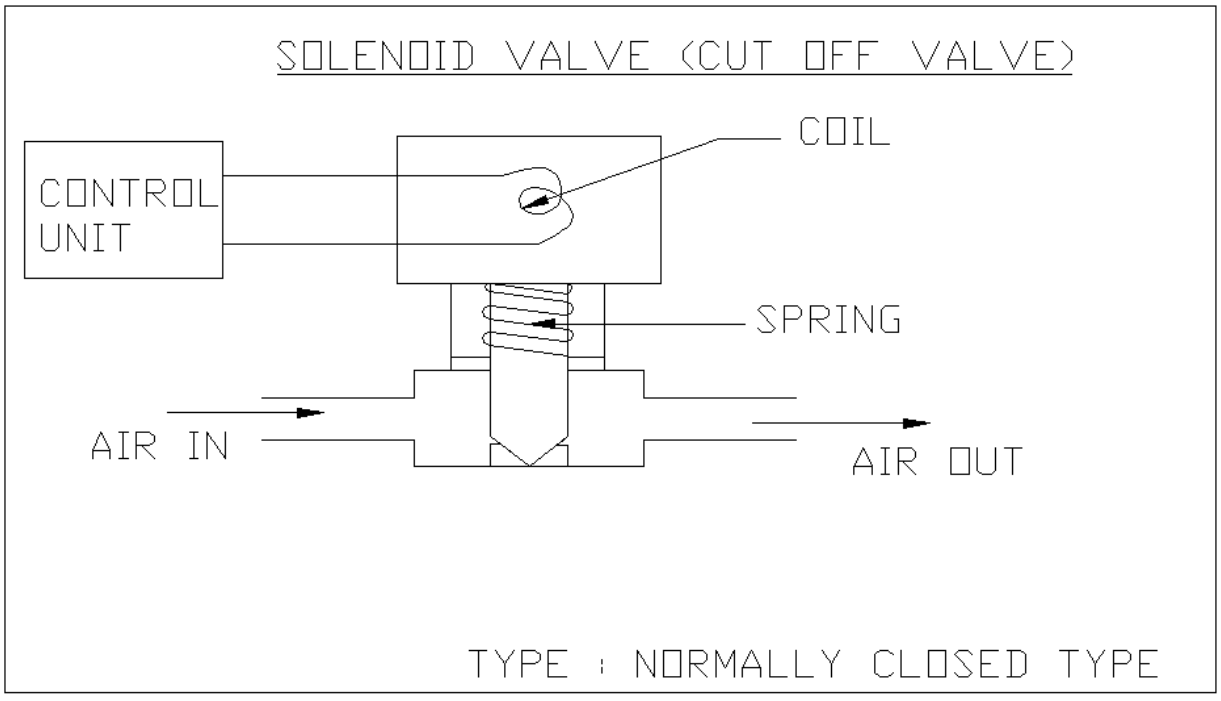
A relay is nothing but a switch mostly switches are manually operated type. But the operations has not sufficient in ON and OFF purpose, it has many problems. So we are used automatically operated switches it is worked based on the voltage across the relay coil, an relay consist of an relay coil one pole two contact the pole is a movable one. It is moved to new position by means of voltage is applied to the relay coil. The pole is normally closed contact and another contact is normally opened contact.

4.4 SOLENOID VALVE (OR) CUT OFF VALVE:

The control valve is used to control the flow direction is called cut off valve or solenoid valve. This solenoid cut off valve is controlled by the intelligent control unit. In our project cut of solenoid valve is used for flow direction of braking cylinder. It is used to flow the air from air tank to the single acting cylinder.

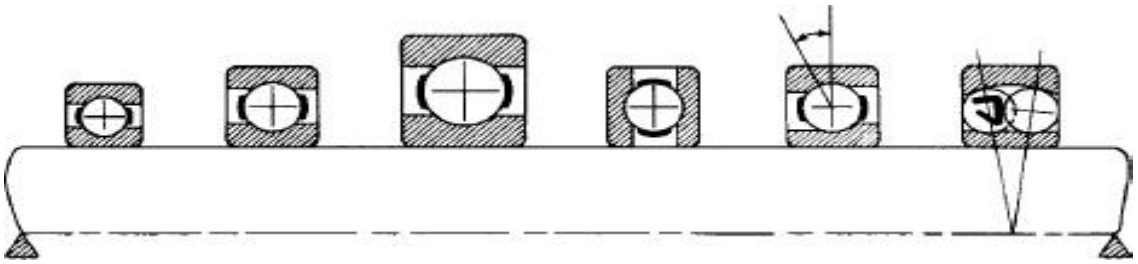
Single acting cylinder

Single acting cylinder is only capable of performing an operating medium in only one direction. Single acting cylinders equipped with one inlet for the operating air pressure, can be production in several fundamentally different designs. Single cylinders develop power in one direction only. Therefore no heavy control equipment should be attached to them, which requires to be moved on the piston return stoke single action cylinder requires only about half the air volume consumed by a double acting for one operating cycle.



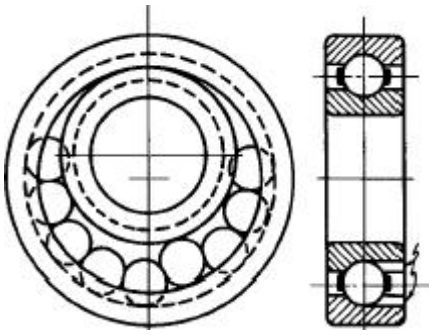
4.5 BEARING WITH BEARING CAP:

For supporting the rolling parts of our project, we have used “Ball Bearings”. A ball bearing usually consists of four parts: an inner ring, an outer ring, the balls and the cage or separator. To increase the contact area and permit larger loads to be carried, the balls run in curvilinear grooves in the rings. The radius of the groove is slightly larger than the radius of the ball, and a very slight amount of radial play must be provided. The bearing is thus permitted to adjust itself to small amounts of angular misalignment between the assembled shaft and mounting. The separator keeps the balls evenly spaced and prevents them from touching each other on the sides where their relative velocities are the greatest. Ball bearings are made in a wide variety of types and sizes. Single-row radial bearings are made in four series, extra light, light, medium, and heavy, for each bore, as illustrated in figure.



100 Series 200 Series 300 Series Axial Thrust Angular Contact Self-aligning Bearing Fig. 1-3 Types of Ball Bearings

The heavy series of bearings is designated by 400. Most, but not all, manufacturers use a numbering system so devised that if the last two digits are multiplied by 5, the result will be the bore in millimeters. The digit in the third place from the right indicates the series number. Thus, bearing 307 signifies a medium-series bearing of 35-mm bore. For additional digits, which may be present in the catalog number of a bearing, refer to manufacturer’s details.



Some makers list deep groove bearings and bearings with two rows of balls. For bearing designations of Quality Bearings & Components (QBC), see special pages devoted to this purpose. The radial bearing is able to carry a considerable amount of axial thrust.

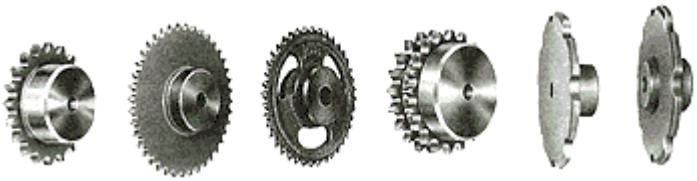
SKF 6208 Ball Bearing

4.6 SPROCKET AND CHAIN DRIVE:

This is a cycle chain sprocket. The chain sprocket is coupled with another generator shaft. The chain converts rotational power to pulling power, or pulling power to rotational power, by engaging with the sprocket.

The sprocket looks like a gear but differs in three important ways:

1. Sprockets have many engaging teeth; gears usually have only one or two.
2. The teeth of a gear touch and slip against each other; there is basically no slippage in a sprocket.
3. The shape of the teeth is different in gears and sprockets.



Types of Sprockets

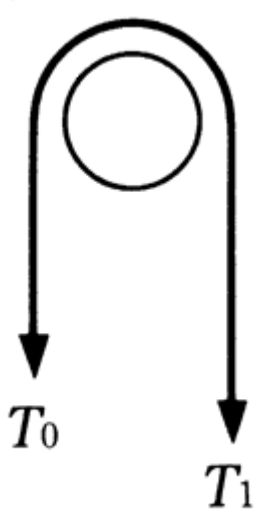
4.6.1 Engagement with Sprockets:

Although chains are sometimes pushed and pulled at either end by cylinders, chains are usually driven by wrapping them on sprockets. In the following section, we explain the relation between sprockets and chains when power is transmitted by sprockets.

1. Back tension

First, let us explain the relationship between flat belts and pulleys. Figure 2.5 shows a rendition of a flat belt drive. The circle at the top is a pulley, and the belt hangs down from each side. For elements without teeth such as flat belts or ropes, the way to get more drive power is to increase the coefficient of friction or wrapping angle. If a substance, like grease or oil, which decreases the coefficient of friction, gets onto the contact surface, the belt cannot deliver the

required tension. In the chain's case, sprocket teeth hold the chain roller. If the sprocket tooth configuration is square, the direction of the tooth's reactive force is opposite the chain's tension, and only one tooth will receive all the chain's tension. Therefore, the chain will work without back tension.



Flat Belt Drive

4.6.2 Basic Structure of Power Transmission Chain

A typical configuration for RS60-t

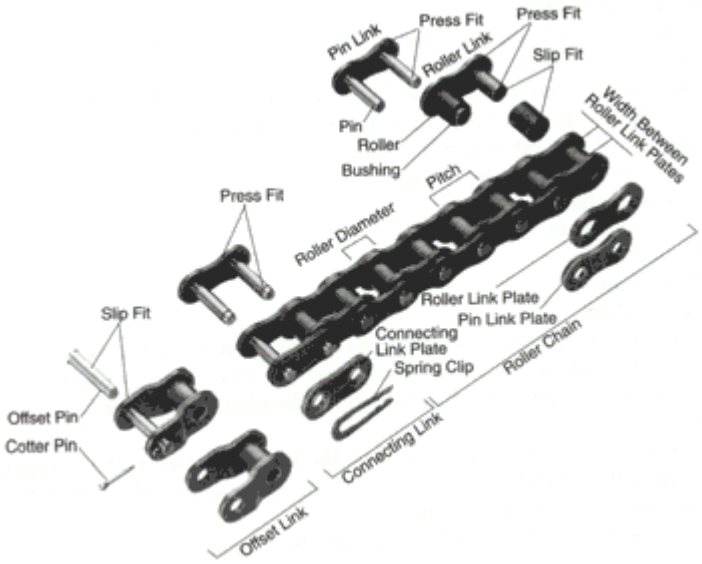


Fig. The Basic Components of Transmission Chain

Connecting Link

This is the ordinary type of connecting link. The pin and link plate are slip fit in the connecting link for ease of assembly. This type of connecting link is 20 percent lower in fatigue strength than the chain itself. There are also some special connecting links which have the same strength as the chain itself. (See Figure 1.2)

Tap Fit Connecting Link

In this link, the pin and the tap fit connecting link plate are press fit. It has fatigue strength almost equal to that of the chain itself. (See Figure 1.2)

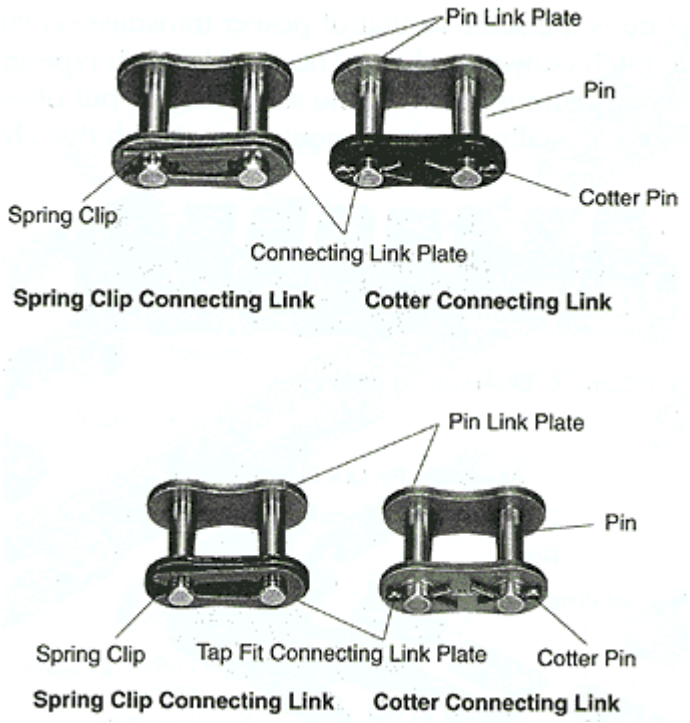


Fig. Standard Connecting Link (top)

and Tap Fit Connecting Link (bottom)

Chain and Sprocket

4.7 D.C. MOTOR (PERMANENT MAGNET):

4.7.1 Description of DC Motor

An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction is given by Fleming's left hand rule. When a motor is in operation, it develops torque. This torque can produce mechanical rotation. DC motors are also like generators classified into shunt wound or series wound or compound wound motors.

4.7.2 Fleming's Left Hand Rule:

Keep the force finger, middle finger and thumb of the left hand mutually perpendicular to one another. If the fore finger indicates the direction of magnetic field and middle finger indicates direction of current in the conductor, then the thumb indicates the direction of the motion of conductor.

4.7.3 Principle of Operation of DC Motor:

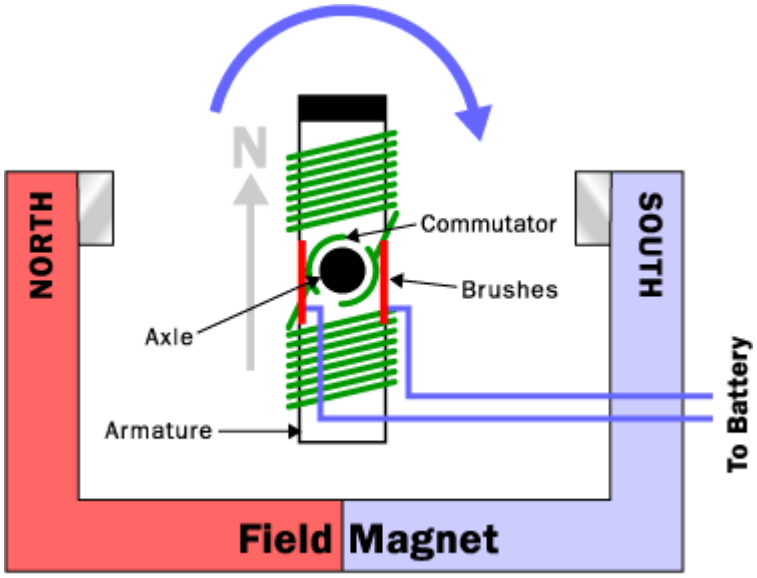
Figure I show a uniform magnetic field in which a straight conductor carrying no current is placed. The conductor is perpendicular to the direction of the magnetic field. In figure II the conductor is shown as carrying a current away from the viewer, but the field due to the N and S poles has been removed. There is no movement of the conductor during the above two conditions. In figure III the current carrying conductor is placed in the magnetic field. The field due to the current in the conductor supports the main field above the conductor, but opposes the main field below the conductor.

The result is to increase the flux density in to the region directly above the conductor and to reduce the flux density in the region directly below the conductor. It is found that a force acts on the conductor, trying to push the conductor downwards as shown by the arrow. If the current in

the conductor is reversed, the strengthening of flux lines occurs below the conductor, and the conductor will be pushed upwards. Now consider a single turn coil carrying a current as shown in the above figure. In view of the reasons given above, the coil side A will be forced to move downwards, whereas the coil side B will be forced to move upwards. The forces acting on the coil sides A and B will be of same magnitude. But their direction is opposite to one another. As the coil is wound on the armature core which is supported by the bearings, the armature will now rotate. The commutator periodically reverses the direction of current flow through the armature. Therefore the armature will have a continuous rotation.

A simplified model of such a motor is shown in figure. The conductors are wound over a soft iron core. DC supply is given to the field poles for producing flux. The conductors are connected to the DC supply through brushes. Let's start by looking at the overall plan of a simple 2-pole DC electric motor. A simple motor has 6 parts, as shown in the diagram below.

- An armature or rotor
- A commutator
- Brushes
- An axle
- A field magnet
- A DC power supply of some sort

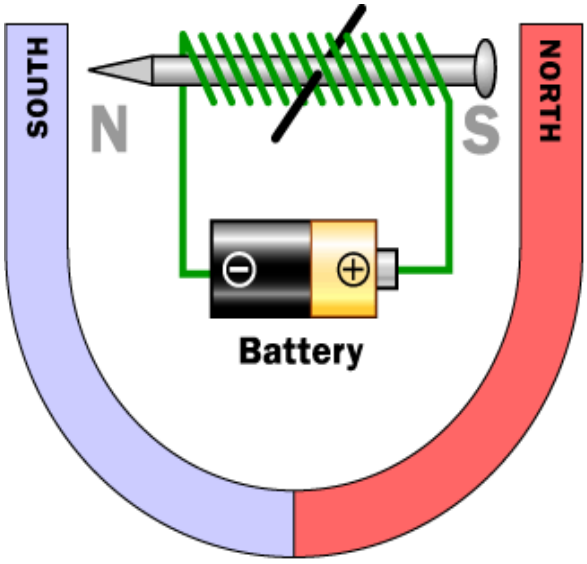


An electric motor is all about magnets and magnetism: a motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets: Opposites attract and likes repel. So if you have 2 bar magnets with their ends marked north and south, then the North end of one magnet will attract the South end of the other. On the other hand, the North end of one magnet will repel the North end of the other (and similarly south will repel south). Inside an electric motor these attracting and repelling forces create rotational motion. In the diagram above and below you can see two magnets in the motor, the armature (or rotor) is an electromagnet, while the field magnet is a permanent magnet (the field magnet could be an electromagnet as well, but in most small motors it is not to save power).

4.7.4 Electromagnets and Motors:

To understand how an electric motor works, the key is to understand how the electromagnet works. An electromagnet is the basis of an electric motor. You can understand how things work in the motor by imagining the following scenario. Say that you created a simple electromagnet by wrapping 100 loops of wire around a nail and connecting it to a battery. The nail would become a magnet and have a North and South pole while the battery is connected. Now say that you take your nail electromagnet, run an axle through the middle of it, and you

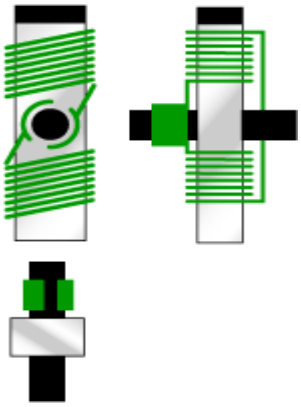
suspended it in the middle of a horseshoe magnet as shown in the figure below. If you were to attach a battery to the electromagnet so that the North end of the nail appeared as shown, the basic law of magnetism tells you what would happen: The North end of the electromagnet would be repelled from the north end of the horseshoe magnet and attracted to the south end of the horseshoe magnet. The South end of the electromagnet would be repelled in a similar way. The nail would move about half a turn and then stop in the position shown.



You can see that this half-turn of motion is simple and obvious because of the way magnets naturally attract and repel one another. The key to an electric motor is to then go one step further so that, at the moment that this half-turn of motion completes, the field of the electromagnet flips. The flip causes the electromagnet to complete another half-turn of motion.

You flip the magnetic field simply by changing the direction of the electrons flowing in the wire (you do that by flipping the battery over). If the field of the electromagnet flipped at just the right moment at the end of each half-turn of motion, the electric motor would spin freely.

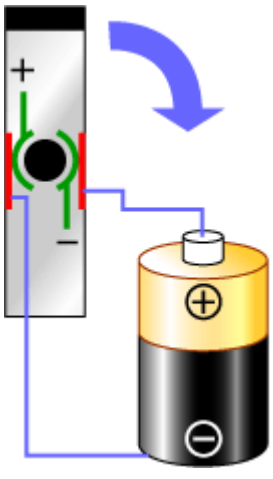
4.7.5 The Armature:



The armature takes the place of the nail in an electric motor. The armature is an electromagnet made by coiling thin wire around two or more poles of a metal core. The armature has an axle, and the commutator is attached to the axle. In the diagram above you can see three different views of the same armature: front, side and end-on. In the end-on view the winding is eliminated to make the commutator more obvious. You can see that the commutator is simply a pair of plates attached to the axle. These plates provide the two connections for the coil of the electromagnet.

4.7.6 The Commutator and brushes:

The "flipping the electric field" part of an electric motor is accomplished by two parts: the commutator and the brushes. The diagram at the right shows how the commutator and brushes work together to let current flow to the electromagnet, and also to flip the direction that the electrons are flowing at just the right moment. The contacts of the commutator are attached to the axle of the electromagnet, so they spin with the magnet. The brushes are just two pieces of springy metal or carbon that make contact with the contacts of the commutator.



D.C. Gear Motor (Wiper Motor)

4.8 IR SENSOR UNIT-OBSTACLE

It consists of an IR transmitter and an IR receiver. In our machine, the Sensor Unit is used to detect a vacant space in the wall such as in case of a window or door, so as to stop the spraying of paint at such vacant spaces. It is fixed to the painting unit of the machine, at the same level as the spray gun.

At normal conditions, when there is a solid wall in front, the transmitter sends IR rays and it is reflected by the wall which is received by the receiver. Hence in the condition when the receiver has an input, the micro controller will send a signal to the solenoid valve. This will open the solenoid valve, resulting in the free entering of compressed air via the solenoid valve, to the spray gun.

At abnormal conditions, when there is a vacant space in the wall, such as in case of a window or a door, the receiver will not be having any input, the micro controller will not be sending any signal to the solenoid valve, and hence the solenoid valve will remain closed. Thereby implying that, paint will not be sprayed when the sensor unit detects a vacant space in the wall.

4.9 SPRAY GUN

A spray gun is a hand-held tool, used for painting. A spray gun always contains a trigger, a reservoir and a liquid, and it requires pumping action for results.

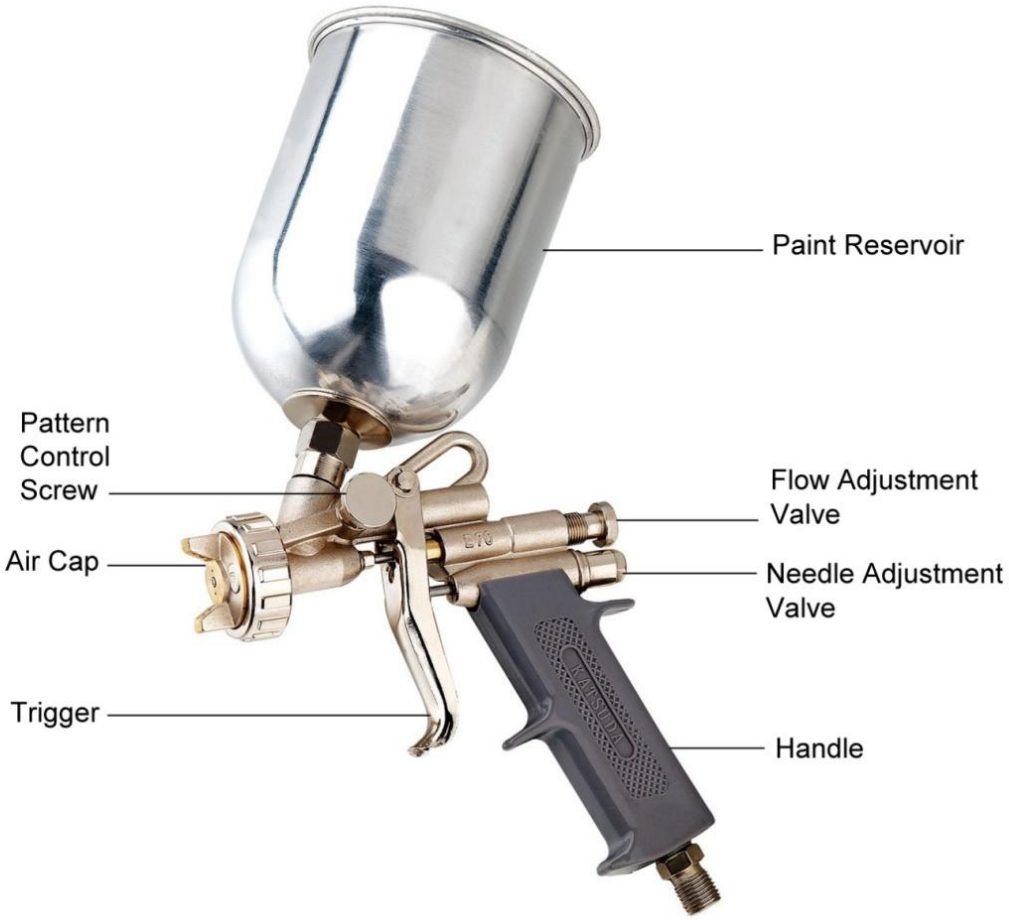
Spraying is an efficient way of painting a large area in a relatively short space of time, such as the outside wall of a building. Spray guns are expensive to buy, consisting of a paint reservoir, nozzle and an electric compressor. They are more suited to outside work as there is so much preparation required for use indoors. Windows, doors and flooring should be masked or covered before the start. It is also sensible to wear a mask and goggles before commencing. If spraying inside, make sure there is plenty of ventilation and if possible use an extractor fan to aid aeration. Always keep the gun facing directly onto the front of the wall and move it up and down, keeping the movements parallel to the surface. If the paint starts to run, the gun is probably too close to the wall. Always try a small test area first to become confident with the equipment and to check the consistency of the paint spraying, also the ideal distance away from the wall to spray for the best finish.

4.9.1 Cleaning the spray gun afterwards

Remove any unused paint from the container.

If water based paint was used, fill with water and spray until it emerges clear. Dismantle the machine and clean the different parts with a damp cloth.

If oil based paint was used, clean as above, but use white spirit instead of water. When clear of paint, clean with a hot water/detergent mix.



SPRAY GUN
(with zinc alloy gun body)

CHAPTER 5

SPECIFICATION

5. SPECIFICATION

5.1 Base Frame and Painting Unit Frame (Body)

The material used for the body is mild steel bars of L-section. The main property of this material is that the material is very strong and durable. We use arc welding for our complete process of fabrication of the body.

Thickness of the Bar : 2.5mm

Section: L- Section

5.2 Wheels

Four wheels have been used for the translational motion of the machine.

Numbers: 4

Wheel Material : Polyurethane

Wheel Diameter: 10mm

5.3 Shafts

Cast steel rods have been used as shafts for the wheels in the machine. Also a set of cast steel rods have been welded on the painting unit, which serve as guides to the up-down motion of the spray gun.

Quantity: 4

Material : Cast Steel

Diameter: 2mm

5.4 DC Gear Motors

Numbers: 2

Input Voltage: 12V, DC

Ampere Rating: 4A

5.5 Battery

It supplies power to the micro-controller and the two DC motors.

Type: Lead Acid (Wet Cell)

Output Voltage: 12V

Volt-Ampere Rating: 12Ah

5.6 Solenoid Valve

Input: 240V, 50Hz

Working Pressure: 1.2-8 Kg/cm^2

Type: Normally closed type

5.7 Spur Gears

Spur gears for transverse motion

Pinion:	Number of teeth	= 22
	Diameter	= 45mm
Gear:	Number of teeth	= 51
	Diameter	= 10mm

Spur gears for vertical motion

Pinion:	Number of teeth	= 16
	Diameter	= 30mm
Gear:	Number of teeth	= 80
	Diameter	= 100mm

5.8 Bearings

In the project, Ball bearings have been used for supporting the four wheels, as well as the 2 sprockets.

Quantity: 8

Type: SKF 6202

d: 15mm

D: 35mm

Dynamic Capacity: 5980N

Maximum Permissible Speed: 16000 rpm

5.9 Compressor

Type: Rotary

Model: VAYU SA10101

Displacement: 107cc

Working Pressure: 10kg/cm^2

Speed: 2880 rmp

5.10 Spray Gun

Type: Conventional type

Nozzle: Full Cone

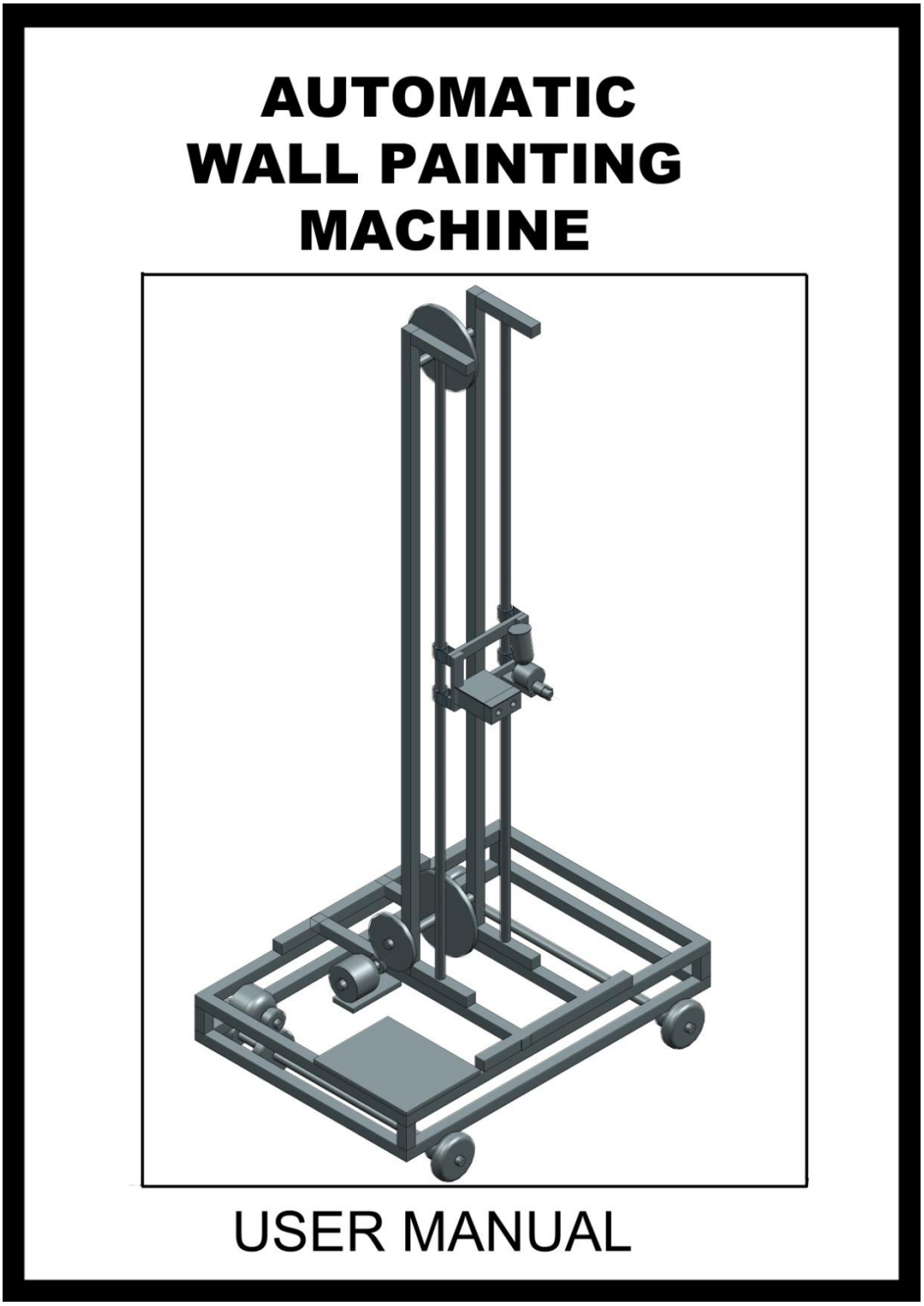
Capacity: 0.5L

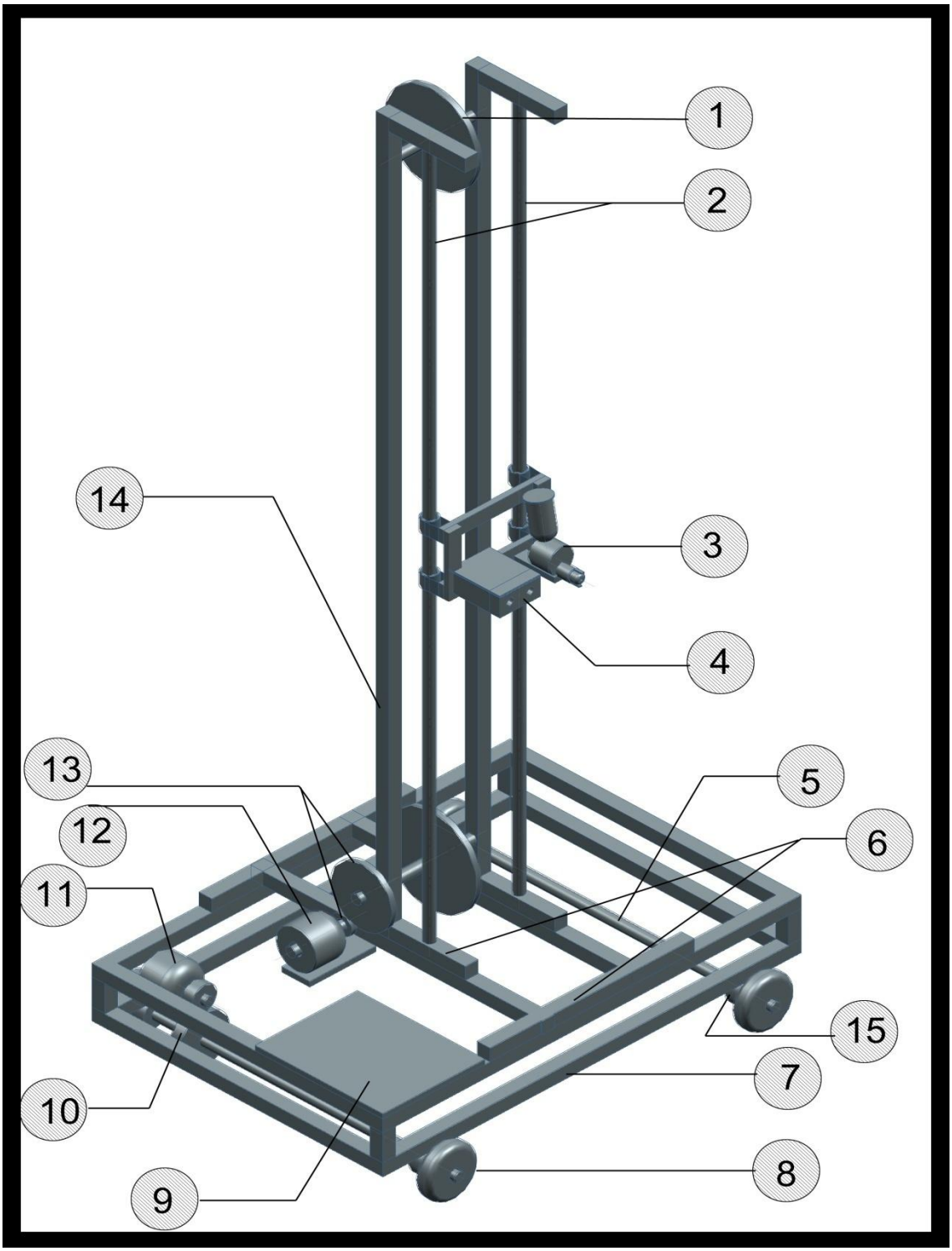
Nozzle Diameter: 1.6mm

CHAPTER 6

USER MANUAL

6. USER MANUAL

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6.1 PARTS

1. Sprocket
   For transmitting the drive for the painting unit.

2. Guide Rods
   Guides the motion of the spray gun and the sensor unit.

3. Spray Gun
   Stores the paint and sprays it.

4. Sensor Unit
   Senses the vacant spaces on the walls, such as windows and doors.

5. Shaft
   Supports the wheels.

6. Detachable Frame of the Painting Unit
   For ease of transportation, and flexibility of the machine.

7. Base Frame
   Major part of the machine which supports most of its weight.

8. Wheels
   For translational motion of the machine.

9. Control Unit
   It is the brain of the machine. It Takes inputs from the user, processes it, and makes the machine work automatically.

10. Spur Gears for Transatory motion

11. DC Gear Motor for Transatory motion

12. Spur Gears for Up-Down motion

13. DC Gear Motor for Up-Down motion

14. Painting Unit

15. Bearing

Used to support the shaft and the wheels.

6.2 OPERATION

6.2.1 Before Operating the Machine

1. Clean the spray gun before and after every use.
2. Mix the emulsion paint, in the paint to water ratio of 5:2 for best results.
3. Place the machine at the right extreme of the wall before starting, as the machine moves from right to left.
4. Place the machine at a distance such that the nozzle of the spray gun lies around 400-600mm from the wall, for attaining best results.
5. Pour the paint into the reservoir of the spray gun before starting the machine.
6. Check for the graduated scale made on the painting unit. Check the height to which the wall has to be painted. Note the corresponding graduation on the painting unit. That is the value to be entered when the machine asks for “PAINTING DISTANCE”.

6.2.2 How to Operate the Machine

1. Switch ON the compressor and let the pressure build up to around 6-8Kg/cm^2.
2. Switch ON the Automatic Wall Painting Machine and switch ON the power for the solenoid valve as well.
3. The display on the machine will show “AUTOMATIC WALL PAINTING MACHINE”
4. Press “ENTER”
5. Now the Screen will display “MOVING DISTANCE”.
6. Press the “INCREMENT” or “DECREMENT” switches and bring it to a required value (preferably in the range of 20-50)
7. Then Press “SET” button.
8. Now the Screen will display “PAINTING DISTANCE”.
9. Press the “INCREMENT” or “DECREMENT” switches and bring it to a required value (preferably between 1-15)
10. Then Press “SET” button.
11. Now with the lock attachment provided next to the trigger of the spray gun, lock the trigger. This will open the nozzle and start the paint spraying.
12. Simultaneously press the “START” switch on the PCB of the machine.
13. Press the “STOP” button, when the machine is to be stopped.
14. Before switching “OFF” the machine, bring the spray gun to its bottom most position using the auxiliary switch provided on the side of the painting unit.

6.2.3 Precautions:

1. Do not start the machine with the spray gun in a position other than its lowermost position.
2. Do not operate the machine if the battery is low.
3. Do not place the machine too close or too far away from the wall.
4. Do not cover the sensor unit while painting occurs.
5. Do not use the spray gun without cleaning.
6. Make sure the compressor pressure does not exceed beyond 8kg/cm^2.
7. Make sure the paint is diluted or thinned, otherwise it may block the nozzle often.

CHAPTER 7

WORKING

7.WORKING

For the automatic working of the machine, the micro controller has been programmed in such a way that it first asks for the following data:

1. Moving Distance
2. Painting Distance

Assume the case where the user inputs are as follows

Moving Distance = 50 (Corresponds to 15mm towards the right)

Painting Distance = 15 (Corresponds to 7.2X15 = 108mm)

7.1 Automatic Control of the Motions

There are three relay switches in the PCB. The RELAY SWITCHES are programmed to be ON and OFF in the following sequence. RELAY1 actuates the motor that controls translational motion. RELAY2 and RELAY3 actuate the control of the motor for Up and Down motion.

1. First the RELAY1 is on, the machine moves 15mm to the right. Meanwhile RELAY2 and RELAY3 will be off.
2. Next the RELAY2 is on, the Painting Unit moves upward till it covers 108mm. Meanwhile RELAY1 and RELAY3 will be off.
3. Now the RELAY1 is on, the machine moves 15mm to the right. Meanwhile RELAY2 and RELAY3 will be off.
4. When the RELAY3 is on, the Painting Unit moves downward until it covers 108mm. Meanwhile RELAY2 and RELAY1 will be off.
5. The sequence continues until the “STOP” button is pressed.

7.2 Automatic Control of the Paint Spraying

This involves the coordination between the micro controller, the solenoid valve, and the sensor unit. At normal conditions, when there is a solid wall in front, the transmitter sends IR rays and it is reflected by the wall which is received by the receiver. Hence in the condition when the receiver has an input, the micro controller will send a signal to the solenoid valve. This will open the solenoid valve, resulting in the free entering of compressed air via the solenoid valve, to the spray gun.

At abnormal conditions, when there is a vacant space in the wall, such as in case of a window or a door, the receiver will not be having any input, the micro controller will not be sending any signal to the solenoid valve, and hence the solenoid valve will remain closed. Thereby implying that, paint will not be sprayed when the sensor unit detects a vacant space in the wall.

CHAPTER 8

TESTING AND COMPARISON

8.TESTING AND COMPARISON

8.1 Testing

Note: For all the below mentioned tests, we have used emulsion paint. The paint has also been diluted to a paint to water ratio of 5:2. The Compressor pressure is maintained in the range of 6-7 Kg/cm^2.

8.1.1 Test 1

To find the free range and maximum cone diameter of the spray gun.

Procedure:

1. The spray gun is held freely in hand first.
2. The inlet of the spray gun is connected to the compressor tube and the compressor outlet valve is opened.
3. Paint is poured into the reservoir of the spray gun.
4. The pattern control screw is kept open to its maximum level so that maximum cone diameter is obtained.
5. Now the paint is sprayed to the wall instantly by holding the trigger.
6. Measure the diameter of the spray pattern, for various distances of nozzle from the wall.

Sl. No	Nozzle to Wall Distance (mm)	Pattern Diameter (mm)	Comment
1.	200	80	Concentrated pattern, dripping of paint
2.	300	95	Concentrated pattern, very les dripping of paint
3.	400	125	Bright pattern, uniformly sprayed
4.	500	130	Bright pattern, uniformly sprayed
5.	600	150	Bright pattern, uniformly sprayed
6.	650	180	Lighter pattern, Uniformly sprayed
7.	750	240	Lighter pattern, Uniformly sprayed
8.	850	200	Very light, barely seen

The spraying range of the spray gun that gave best appearance with a uniform application of paint is between 400-750mm. Hence it is clear that the Automatic Wall Painting Machine should also be place to paint within this range of distances from the wall to the nozzle.

8.1.2 Test 2:

To find the free range and maximum cone diameter of the spray gun, considering the range of the IR Sensor.

Procedure:

1. The machine is switched ON. The Compressor outlet is Connected to the solenoid valve.
2. Paint is poured into the spray gun reservoir, which is now attached to the painting unit of the machine.
3. Various input are fed into the Control Unit.
4. The operation is started.
5. The test is conducted by moving a small plane aluminium sheet in front of the painting unit at various distances from the nozzle.

Sl. No	Nozzle to Wall Distance (mm)	Pattern Diameter (mm)	Response of the IR Sensor
1.	200	80	Detects object
2.	300	95	Detects object
3.	400	125	Detects object
4.	500	130	Detects object
5.	600	160	Detects object
6.	650	180	Does not detect objects
7.	750	240	Does not detect objects
8.	850	200	Does not detect objects

It is noted that, the range of the IR sensor is limited to 620mm, after which it is unable to detect objects.

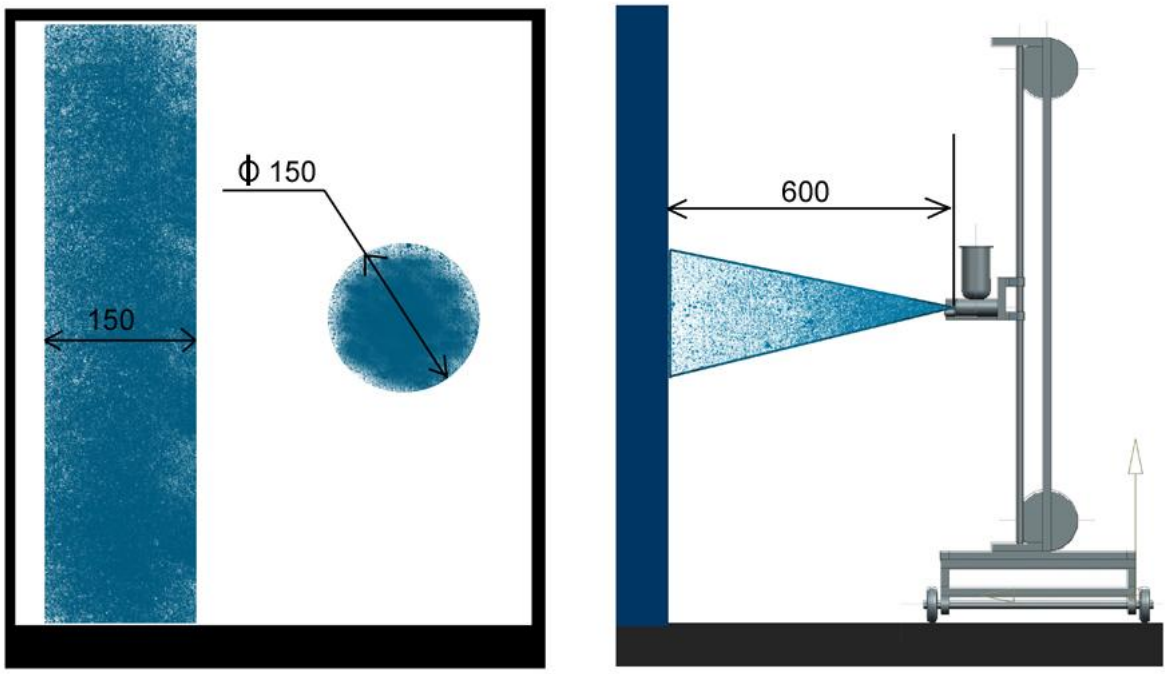
Inference:

From the above 2 tests is noted that the machine should be kept at a range of 45-60mm from the wall for most efficient painting. The corresponding diameters of the spray pattern lie in the range of 120-150mm.

Since we want maximum area to be covered in minimum time, we chose the distance 60mm as the pattern diameter is maximum in that case.

OPTIMUM PAINTING DISTANCE

(With its corresponding Max. Spray Pattern Diameter)



All dimensions are in mm

8.2 Test Results:

Working Pressure	: 6-7 Kg/cm^2
Paint	: Emulsion Paint
Paint to Water ratio	: 5:2
Optimum Painting distance (Wall to Nozzle Distance)	: 600mm
Pattern Diameter (at 600mm painting distance)	: 150mm
Time taken to cover an area of 1X0.15m^2	: 14 sec
Time taken to cover an area of 1X5m^2	: 8 minutes + 3 minutes for setting and paint refilling = 11 minutes

8.3 Comparisons with Manual Painting

	Manual Painting	**AUTOMATIC WALL PAINTING**	**Inference**
Time required to paint and area of 1sq.feet	10 sec	14 sec	For painting small area, since the machine involves setting time, it is not preferable.
Time required to paint an area of 1m height and 5m length.	20min	11 minutes	Manual painting may include his resting time since large area painting would involve human fatigue.
Cost of painting per day (exclusive of the cost for paint)	Rs400-Rs600	Rs 100 (considering the machine to be on lease)	A way to commercialize the machine is to provide it on lease from hardware and paint shops etc.
Effects of large area painting	Human Fatigue	No effects	----------
Uniformity of Painting	Skill Dependent	Very Uniform Painting	----------

CHAPTER 9

FABRICATION

9.FABRICATION

1. Mild steel bars of L section are cut to appropriate lengths using a cutter and they are arc welded to form the base frame in a hollow cubical shape.
2. The 4 bearings are arc welded to bottom of the frame.
3. The cast steel rods are inserted through the bearing. One of the shafts is welded with a spur gear for the transmission of translational motion. The wheels are inserted into the rods and the ends are welded to avoid play of the wheels.
4. The first gear motor is bolted to the frame in such a way that the gear pair is meshed.
5. Mild steel bars of L section are cut to appropriate lengths using a cutter and they are arc welded to form the frame of the painting unit. Slots for nuts and bolts are provided at the base of the painting unit so as to attach it to the main frame.
6. Two shafts with bearings and sprockets are welded on the top and bottom of the painting unit.
7. Two guide ways are welded vertically on the painting unit such that the spray gun and IR sensor can move up and down sliding on these guide ways.
8. 3m of chain is wound tightly around the sprocket and is tightly bolted via the spray gun and IR sensor assembly.
9. The control unit circuit board is prepared and micro controller is programmed according to the requirement.
10. The IR Sensor unit is also prepared and linked to the micro controller.
11. The solenoid valve is also linked to the micro controller.
12. The spray gun and IR sensor unit are attached to the movable part of the painting unit such that the nozzle and the sensor are at the same horizontal level.

CHAPTER 10

COST

10. COST

Components	Price (in Rupees)
Compressor	(On Lease)
DC Motor	1200
Wiper Motor	1800
Control Unit	3000
Soleniodal Valve	850
Wheels	80 X 4
Bearing and Bearing Cap	200 X 8
Chain	500 X 3
Sprockets	120 X 2
Spur Gear Sets	250 X 2
Fabrication	2000
Programming Charge	2000
Transportation	750
Spray Gun	950
TOTAL	**Rs 16,710**

CHAPTER 11

IMPROVEMENT

11. Improvements

- **Guide ways:**
  To avoid vibration of the painting unit, especially in case of larger AWPM's, we can provide an auxiliary guideways at the ceiling level from left end of the wall to its right end. The painting unit may move along it.

- **Guide ways for parallel motion:**
  If the alignment of the wheels is not parallel to each other and the wall, the painting distance may vary as the machine moves. As an improvement to this, a set of guide ways can be provided for the wheels of the machine.

- **Supports for the Painting Unit:**
  As the painting unit is made taller, the chance of vibration of the painting unit increases. Hence more rigid and more number of supporting frames can be provided to the painting unit to make it vibration free.

- **Variable Height Painting Unit:**
  A 2-piece painting unit, fixed to the required height using nuts and bolts, can be fabricated for flexibility of height. With such an improvement, the user does not have to worry about the height of his ceiling and can vary the painting height of the machine according to his requirements.
  The following improvements could make our machine accepted widely. With these improvements we expect to cover all its current drawbacks. And hence the abovementioned improvements could very well lead to commercialization of the Automatic Wall Painting Machine.

CHAPTER 12

CONCLUSION

CONCLUSION

The improvements such as guide ways, variable height painting unit, supports for the painting unit, guide ways for parallel motion, etc could make our machine accepted widely. With these improvements we expect to cover all its current drawbacks. And hence the abovementioned improvements could very well lead to commercialization of the Automatic Wall Painting Machine.

The concept of Automatic Wall Painting Machine is expected to be accepted worldwide. Though it has a few limitations, painting of larger areas within lesser duration and economic rates is possible with our equipment. The surface finish of painting achieved with the machine is immensely uniform. Considering all the factors, Automatic Wall Painting Machine would certainly be a breakthrough in the painting methodology.

CHAPTER 13

REFERENCES

13.REFERENCES

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CHAPTER 14

APPENDIX